MULTIMEDIA UNIVERSITY

STUDENT ID NO

TABLE NO: _____

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2016/2017

TCP2101 – ALGORITHM DESIGN AND ANALYSIS

(All Sections / Groups)

4 MARCH 2017
2.30 p. m. – 4.30 p. m.
(2 Hours)

Question	Mark
1	
2	
3	
4	
Total	

INSTRUCTIONS TO STUDENT

1. This Question paper consists of 12 pages with 4 Questions only.

2. Answer all **FOUR** questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in **this Question paper**.

Question 1

a) Given five computer algorithms with time complexities $O(n^2)$, $O(n \log^2 n)$, $O(\log n)$, $O(n^3)$, and $O(n^2 \log n)$. Arrange them according to **descending** (highest → lowest) **growth rate.** [5 marks]

b) The pseudocode for an algorithm named *algoM* is given below. Count the number of primitive operations for each line of the pseudocodes, and then find the time complexity, $T(n)$ of the algorithm in big-O notation. [8 marks]

Algorithm **algoM**(*A*) // *A* is an array with *n* integers	Number of primitive operations
count_4_same_ints ← 0	
for *i*←0 to *n*-4 do	
they_are_same ← TRUE	
for *j*← *i* + 1 to *i* + 3 do	
if *A*[*i*] != *A*[*j*]	
they_are_same ← FALSE	
{increment counter *j*}	
if(*they_are_same*)	
count_4_same_ints++	
{increment counter *i*}	
return *count_4_same_ints*	
$T(n)$	

Continued...

c) What is the **return value** of the algorithm above if array A = {4, 7, 7, 5, 5, 5, 5, 10, 10}? [2 marks]

d) Given two hash functions, i.e. $h_1(k) = k \% 21$ and $h_2(k) = k \% 19$. Which hash function is **better to reduce collision**? **Briefly explain** your answer. [3 marks]

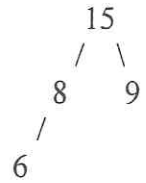
e) Insert the integers in the following order, 35, 65, 97, 58, 22, 32, and 63 into a hash table using this hash function, $h(x) = k \% 13$. Use **linear probing** to handle collision in the hash table. [7 marks]

Continued...

Question 2

a) State the **running times** (in big-O notation) for performing a search in (i) **balanced BST**, and (ii) **unbalanced BST**. [2 marks]

b) **Define** the term **maxheap**. **Explain** (in steps) how to **enqueue** an element 12 into the following heap. Draw the resulting heap after the enqueue. [6 marks]



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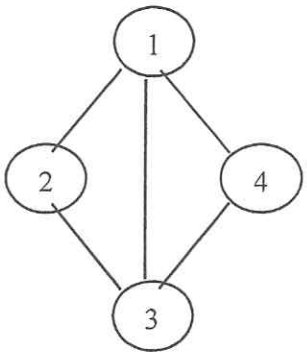
c) The following undirected graph is provided. Write down its adjacency matrix representation and adjacency list representation. [8 marks]



Adjacency Matrix	Adjacency List

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d) The following Selection Sort algorithm is used to sort the array of 7 integers below.
Array: 40 10 40 35 141 188 57 [9 marks]

```
void selectionSort (int a[], int n) {
  for (int i = n-1; i > 0; i--) {
    int maxIndex = i;
    for (int j = 0; j < i; j++) {
       if (a[j] > a[maxIndex])
           maxIndex = j;
    }
    if (maxIndex != i)
      swap (a[i], a[maxIndex]);
  }
}
```

Fill up the table below based on the content at the **end of each outer "for" loop** iteration or i.

i	maxIndex	Array
6		
5		
4		
3		
2		
1		

Continued...

Question 3

a) Sate the **main difference** between "**in-place**" algorithm and "**not-in-place**" algorithm. Give **one example** for each type of algorithm. [5 marks]

b) Complete the summary table with suitable algorithm and time complexity. [5 marks]

Algorithm	Time Complexity	Sorting speed
selection-sort		slow (good for small inputs)
	$O(n \log n)$ $O(n^2)$ for worst case if not randomized	fastest (good for large inputs)
heap-sort		fast (good for large inputs)
		sequential data access fast (good for huge inputs)

Continued...

c) The following **Quick-Select** algorithm is used to find the k-th smallest element in the array below. Notice that the pivot is selected from the last element of the current subarray. Use Quick-Select to find the 4th smallest element in the array. Assume the Partition function is stable. [7 marks]

```
Array: 37, 83, 1, 100, 46, 93, 66, 55, 50, 88, 22
```

```
Algorithm QuickSelect (a, p, r, k)
Input Parameters: array a, start index p, end index r,
                  target smallest k.
Output Parameter: a[k] at the correct position.
   if (p <= r)
        pi = Partition (a, p, r) // pivot index.
        if (k == pi)
             return a[pi]
        if (k < pi)
             QuickSelect (a, p, pi - 1, k)
        else
             QuickSelect (a, pi + 1, r, k)
```

Continued...

d) Define **NP-hard** and **NP-complete**. [2 marks]

e) Use Master Theorem to find the time complexity (in big-O) for the following two equations. The three cases of Master method are shown below: [6 marks]

i. $T(n) = 9T(n/3) + n^2$

ii. $T(n) = 16T(n/2) + n^3 \log n$

The Master Theorem:

1. if $f(n)$ is $O(n^{\log_b a - \varepsilon})$, then $T(n)$ is $\Theta(n^{\log_b a})$
2. if $f(n)$ is $\Theta(n^{\log_b a} \log^k n)$, then $T(n)$ is $\Theta(n^{\log_b a} \log^{k+1} n)$
3. if $f(n)$ is $\Omega(n^{\log_b a + \varepsilon})$, then $T(n)$ is $\Theta(f(n))$, provided $af(n/b) \leq \delta f(n)$ for some $\delta < 1$.

Continued...

Question 4

a) State the **main difference** between **fractional knapsack** problem **and 0/1 knapsack** problem. State the **algorithm design technique** that produces **optimal solution** for fractional knapsack problem and 0/1 knapsack problem respectively. [2 marks]

b) The **knapsack** problem has the following six items; each having its weight and benefit. You are allowed to take fractional amount of an item. Find the maximum total benefit with weight (W) of at most **13**kg. List the **selected items** and the **maximum total benefit**. [8 marks]

Item	A1	A2	A3	A4	A5	A6
Weight (kg)	1	3	7	5	4	8
Benefit	15	6	21	30	28	28

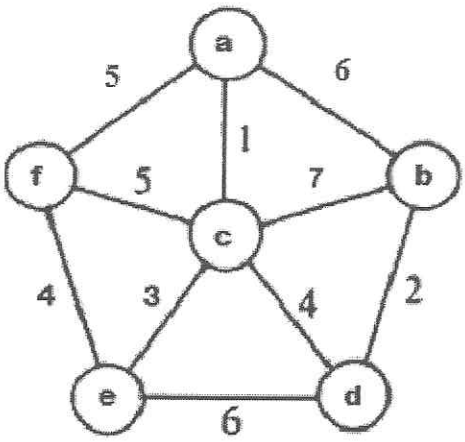
Continued...

c) Show the **steps** when **Boyer-Moore's** algorithm is applied to find the pattern P in the text T provided below. [5 marks]

```
P = SOLUTION
T = IS QUESTIONING A SOLUTION
```

Continued...

d) The following graph is provided. Use **Dijsktra**'s algorithm to find **all shortest paths** from *d*. Show the **intermediate results** (steps) in your answer. [10 marks]



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